Nanotechnology Vision Chip

Implantable device for restoring vision

The National Aeronautics and Space Administration (NASA) is offering the opportunity to license or co-develop a unique technology for stimulating retinal neural cells using an array of carbon nanotubes (CNT). Developed at NASA's Ames Research Center, in conjunction with Stanford University School of Medicine, the "Vision Chip" is designed to restore vision in patients suffering from age-related macular degeneration, the number one cause of blindness in the elderly.

Benefits

- Vision restoration in cases of macular degeneration.
- Strong and durable design will withstand implantation and *in vivo* forces.
- Target cells are in direct contact with CNT towers, to achieve precise and efficient stimulation, as compared to surface electrode technologies.
- Improved signal delivery efficiency over surface electrodes produces less heat, resulting in better tissue compatibility and long-term implant viability.
- Small, nano-sized components allow for an image resolution density similar to that of native retinal photoreceptors.
- Excellent biocompatibility demonstrated in short-term *in vitro* tests of the implant materials with retinal ganglion cells.

Potential Applications

This invention has potential applications for the treatment of a variety of retinal disorders and for vision research. Potential applications include

- **Macular Degeneration –** Enables direct interface with retinal tissue to deliver light-generated electrical signals to the intact neural elements of the retina, as a means to restore vision.
- **Traumatic Eye Damage –** May restore vision in patients with traumatically disrupted retinal tissue, in cases where neural elements are intact. CNT towers coated with growth factors or cytokines may be used as "scaffolds" to direct the regrowth of damaged retinal elements.
- **Ophthalmological Research –** May provide a means to measure electrical activity and neural impulses in the various layers of the retina, in order to better understand the signal "processing" and signal "integration" functions of the retina.

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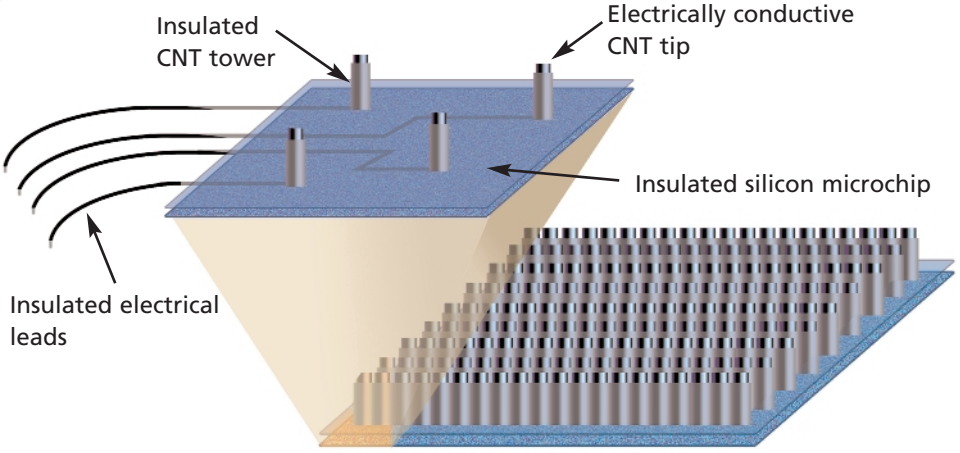
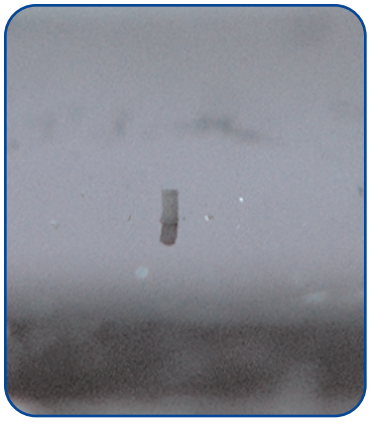
The Technology

The Vision Chip consists of an array of electrically-conductive carbon nanotube (CNT) towers grown directly on the surface of a silicon chip. Each CNT tower in the array is connected to its own electrical circuit, so that electrical signals generated by the pixels of a light detector (such as a charge-coupled device (CCD) chip, worn by the patient) can be transmitted to the CNT towers. For the intended application, thousands of CNT towers are closely spaced in an array, to match the spacing of the neurons within the retina.

More than 15 million Americans suffer from macular degeneration, the leading cause of vision loss in people over the age of 55.



NASA-Stanford Vision Chip Prototype—Schematic Diagram



Light micrograph showing a single element of the Vision Chip array, consisting of a CNT tower grown from a silicon surface.

The device is designed to be implanted into the retina, so that the CNT towers come in direct contact with the retinal neurons. Electrical signals generated by a CCD camera are delivered to the implanted device via telemetry. Prototypes have used towers that are 100 microns in diameter and approximately 150 microns tall. Smaller chips (50-150 microns tall), with arrays of towers spaced 10-25 microns apart are under development. Optimization of dimensions and spacing serves to minimize "cross-talk" within the retinal layer, producing a sharper image for the patient.

In an alternate version of this technology, the CNT towers may be implanted only partway into the retina and coated with special growth factors, to stimulate growth of retinal neurons toward the CNT towers. Carbon nanotubes provide a highly biocompatible surface and may be doped with a variety of growth factors and cytokines to stimulate attachment of neural cells to the CNT towers. With this enhancement, only minimal penetration of the retinal tissue (25-50 microns) may be needed to promote neural cell/CNT tower connections, and restore vision.

Prototypes of the Vision Chip have been implanted in rabbit retinal tissue, demonstrating its ability to survive surgical handling and implantation forces. Short-term *in vitro* tests of the implant materials with retinal ganglion cells suggest excellent biocompatibility. Additional *in vitro* and *in vivo* tests are underway.

Technology Commercialization Status

NASA Ames is currently seeking U.S. companies interested in further development and commercialization of this technology. A patent application has been submitted and opportunities for licensing and development partnerships exist.

For More Information

For more information about this technology or to obtain a license application, contact

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